Impact of Rolling Frequency on Dollar Spot and Soil Moisture

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MSU 1996

No

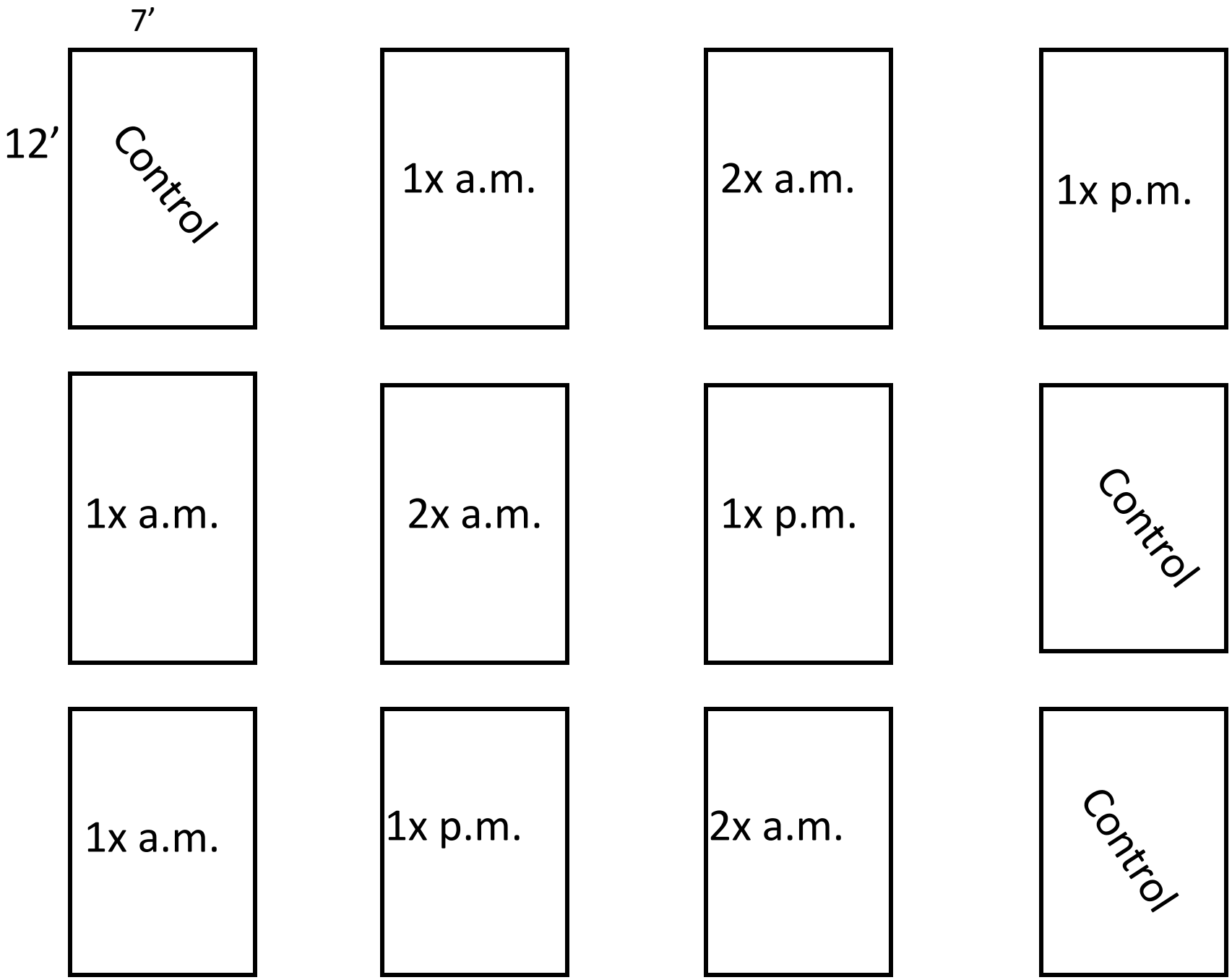
Why rolling may decrease dollar spot activity

- Removes dew
  - (Williams and Powell, 1996; Ellram et al., 2007; Walsh et al., 1999)
- Removes leaf litter
  - (Williams et al., 1996)
- Decrease concentration of guttation
  - (Vargas, 2005; Williams et al., 1996)
- Increases soil moisture holding capacity (altered microbial populations?)
  - Couch and Bloom, 1960; Liu et al., 1995; Nikolai, 2005)
- Induced plant defense responses
  - Nikolai, 2005; Hammerschmidt, (unpublished)

Treatments

- Control (not rolled)
- Rolled once in the A.M.*
- Rolled once in the P.M.*
- Rolled twice in the A.M.*

- *5 days/wk for duration of study
- Randomized block design - 3 replications


7’
12’
Control
1x a.m.
2x a.m.
1x p.m.
1x a.m.
2x a.m.
1x p.m.
Control
1x a.m.
1x p.m.
2x a.m.
Control

Materials and Methods

- USGA green mix soil
  - Topdressed bi-weekly
- Mixed stand *Agrostis stolonifera* cv. '*Independence'* and *Poa annua*
- Tru-Turf R52-11T greens roller
  - Rolled June-October
- Hand mowed 6 days/wk
  - @ 0.156" (3.96mm)
- NO FUNGICIDES

Hypothesis I

- Rolling (typically in the morning), removes excess dew and plant guttation fluid

- Removal/dispersal limits pathogen proliferation
  - Moisture
  - Food source
  - Inoculum

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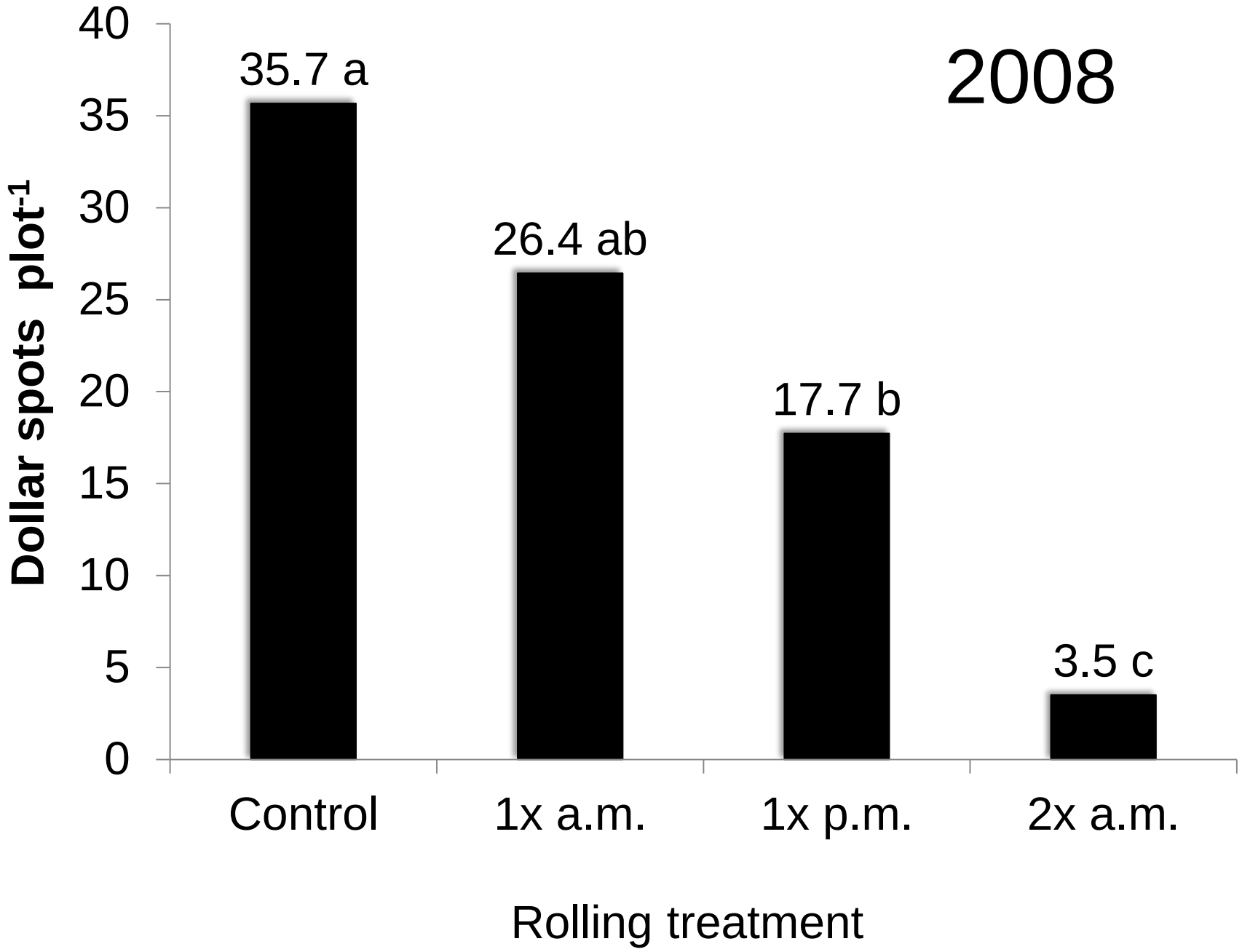
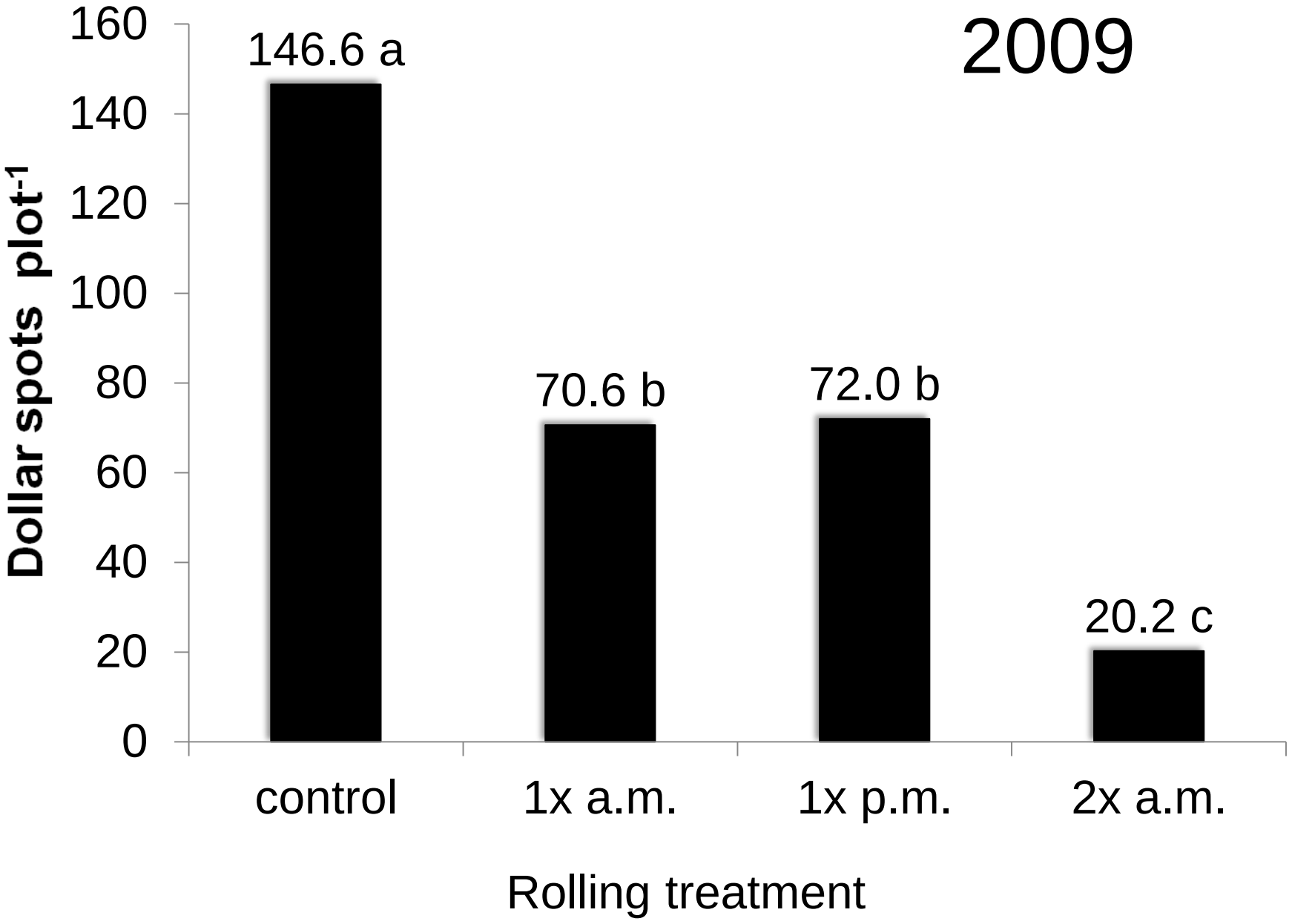
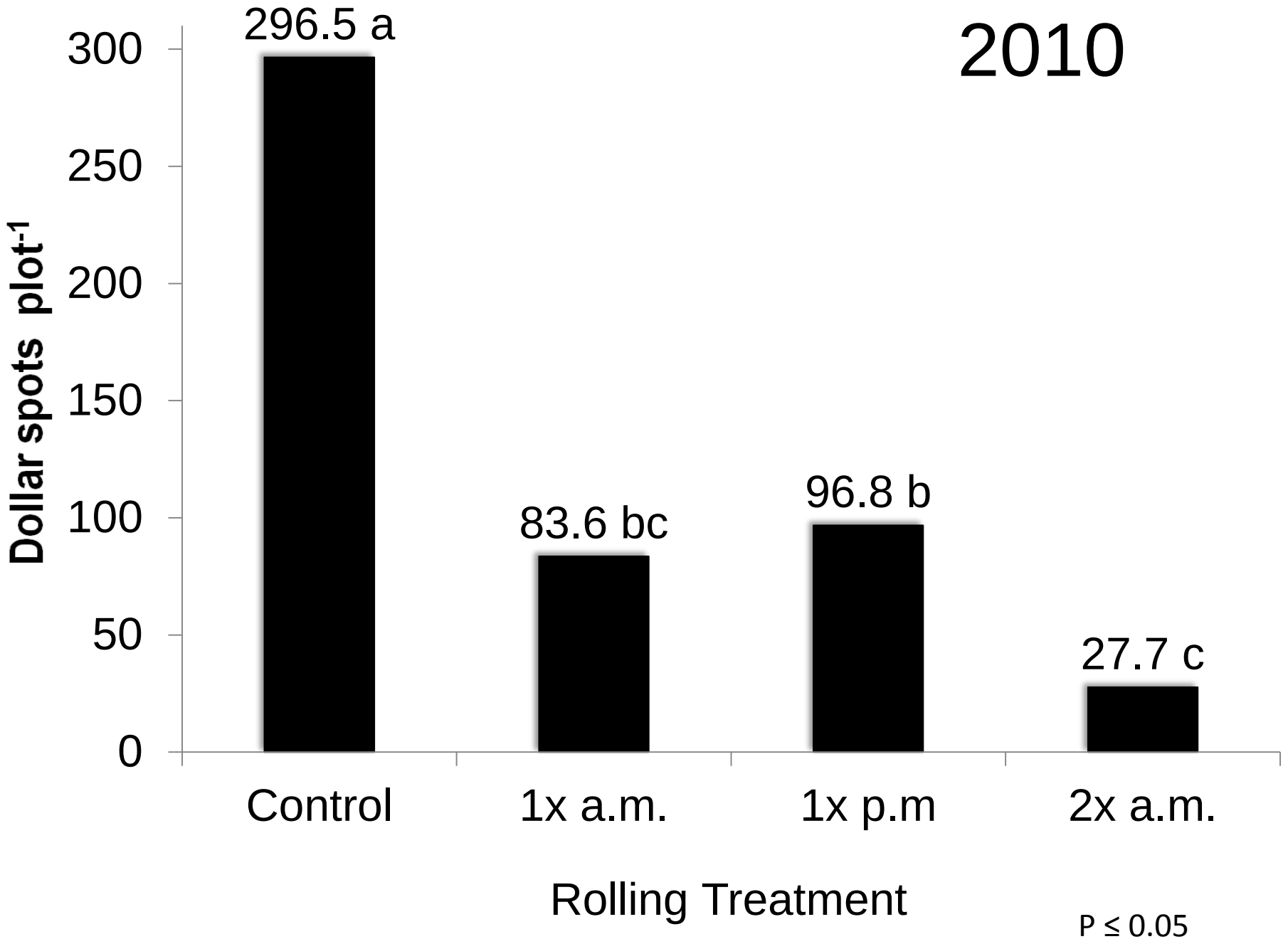
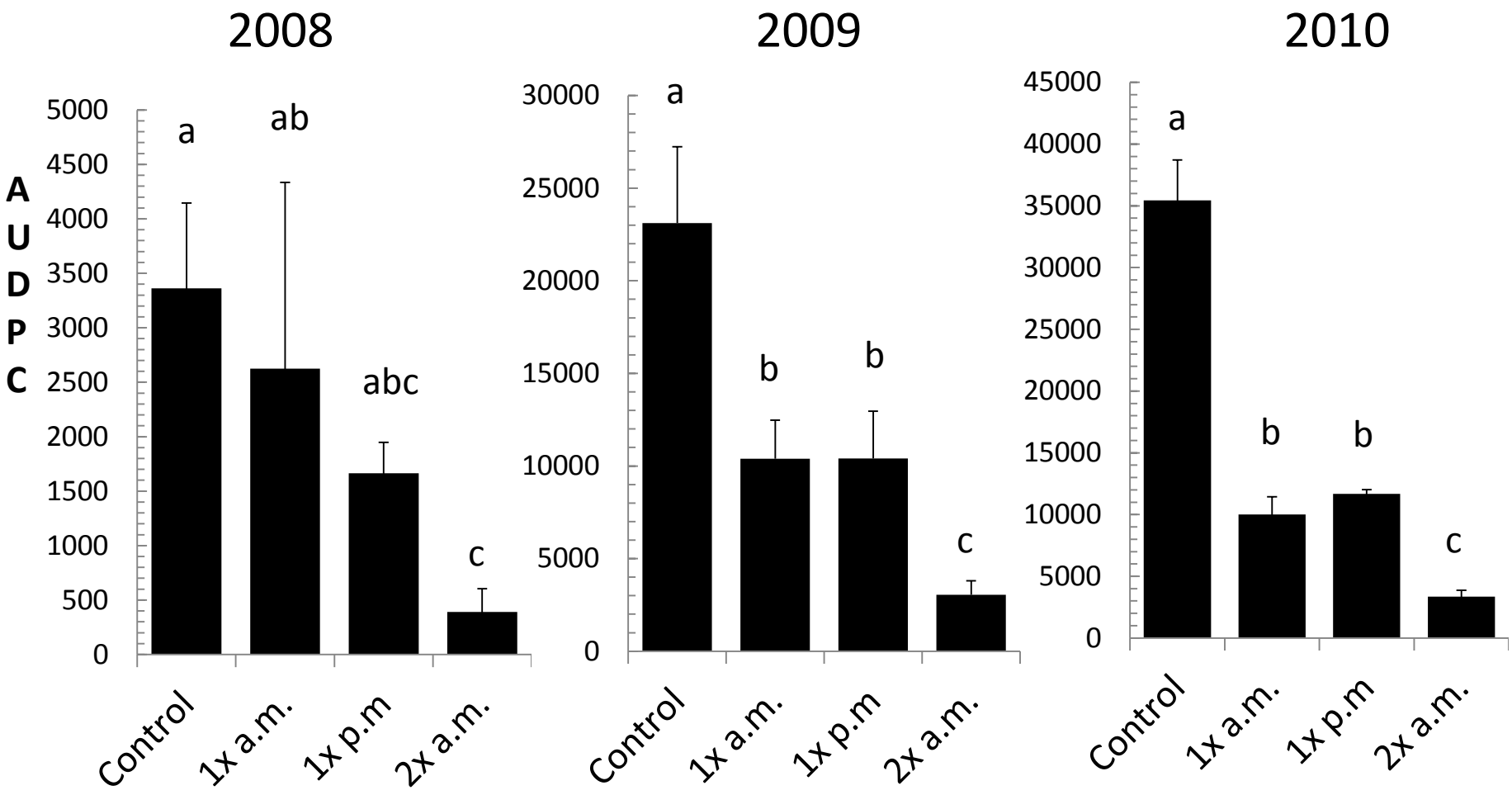

2008
Dollar spots plot-1
40
35
30
25
20
15
10
5
0
35.7 a
26.4 ab
17.7 b
3.5 c
Control
1x a.m.
1x p.m.
2x a.m.
Rolling treatment
P ≤ 0.05

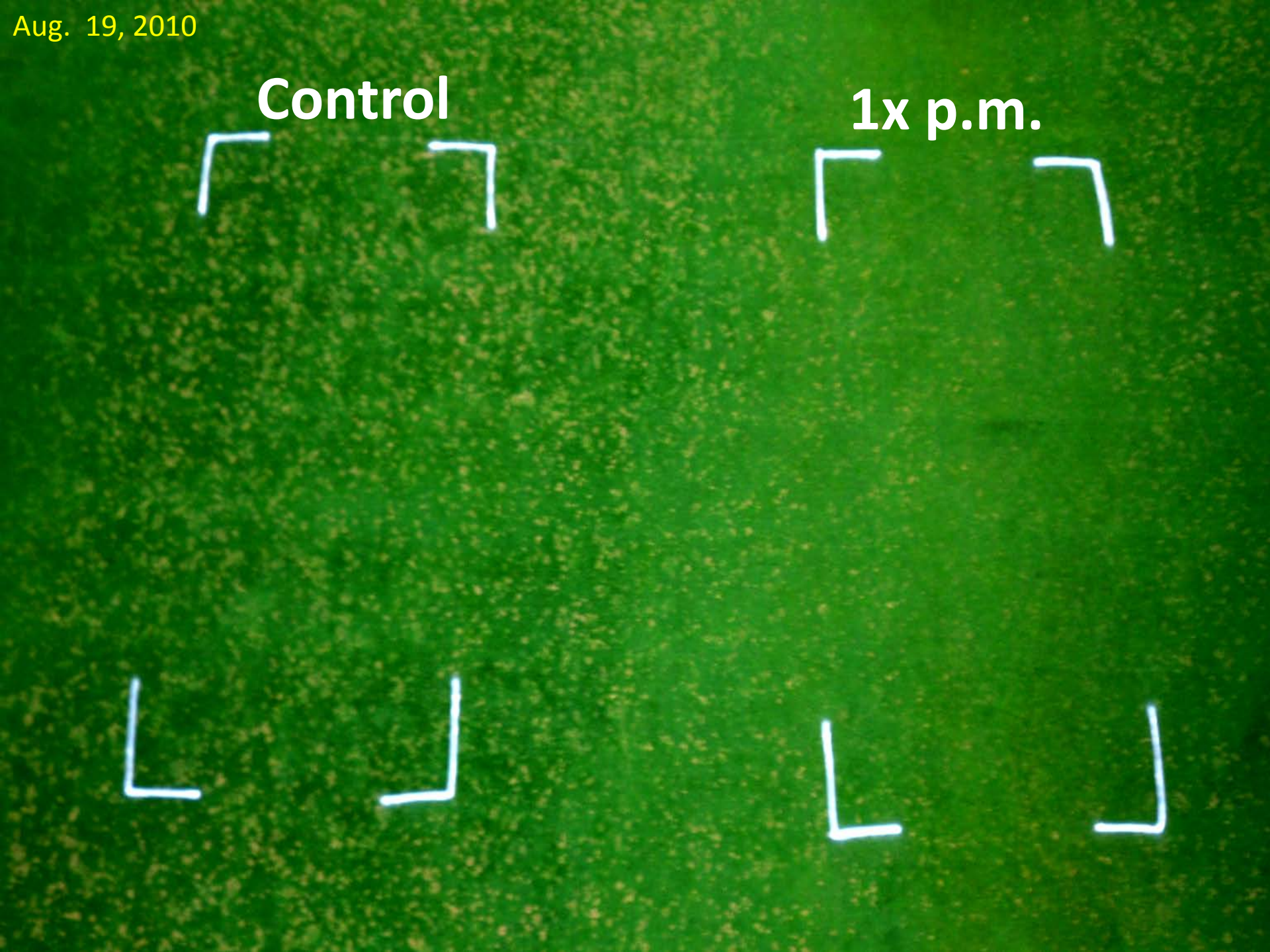

2009
160
140
120
100
80
60
40
20
0
Dollar spots plot-1
146.6 a
70.6 b
72.0 b
20.2 c
control
1x a.m.
1x p.m.
2x a.m.
Rolling treatment
P ≤ 0.05

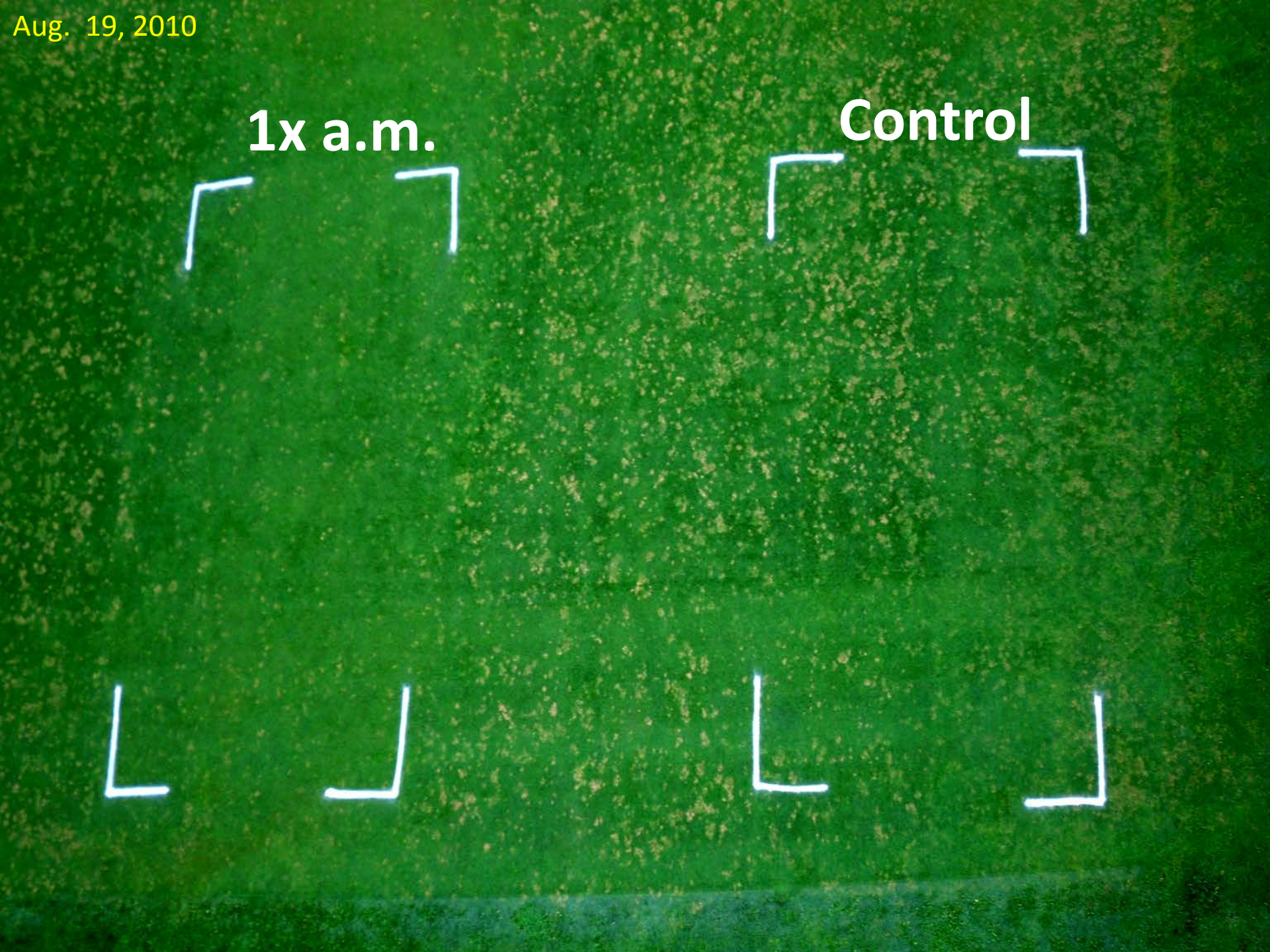

2010
296.5 a
83.6 bc
96.8 b
27.7 c
300
250
200
150
100
50
0
Dollar spots plot-1
Control
1x a.m.
1x p.m
2x a.m.
Rolling Treatment
P ≤ 0.05

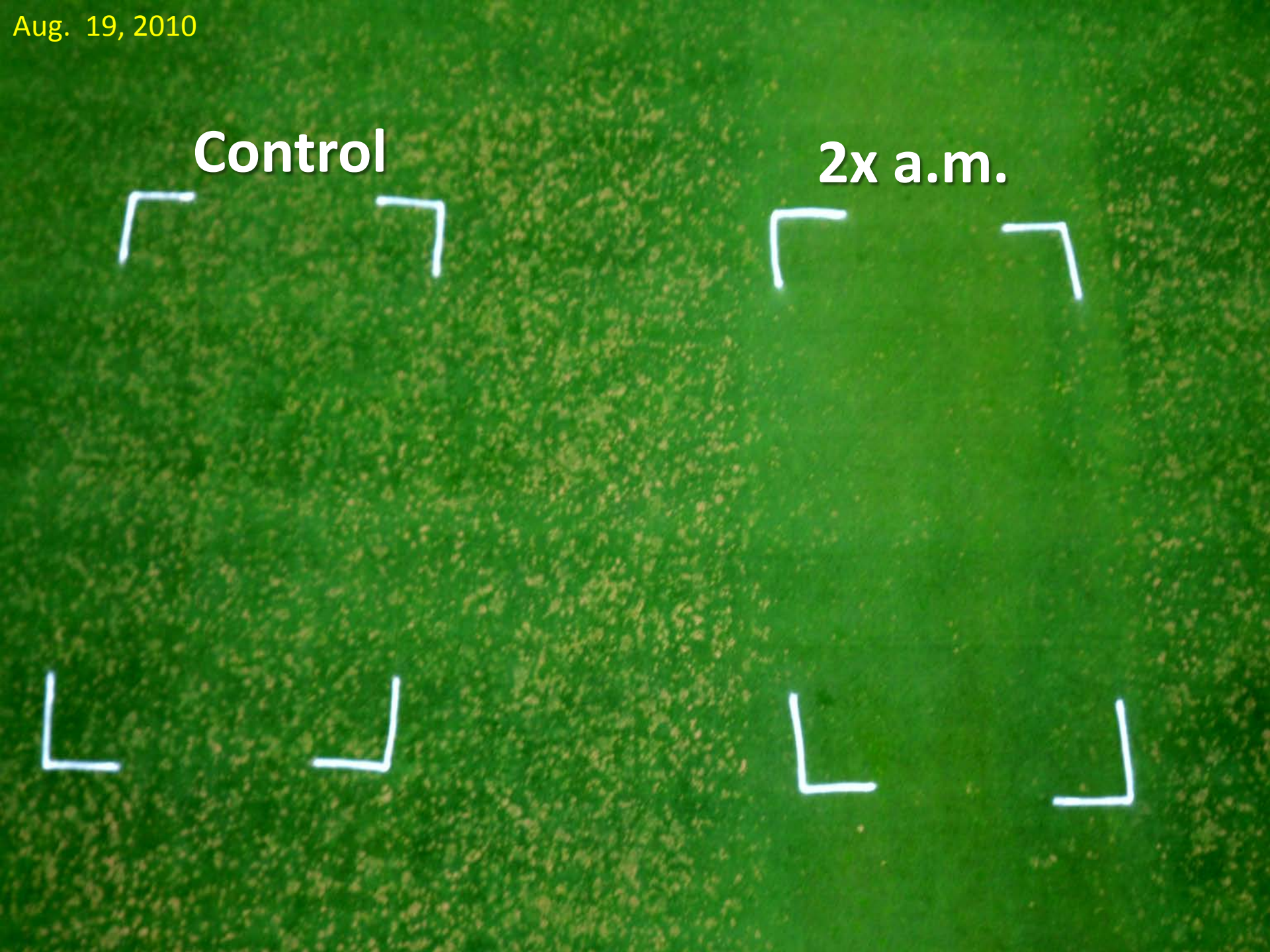
Dollar spot by season (AUDPC)

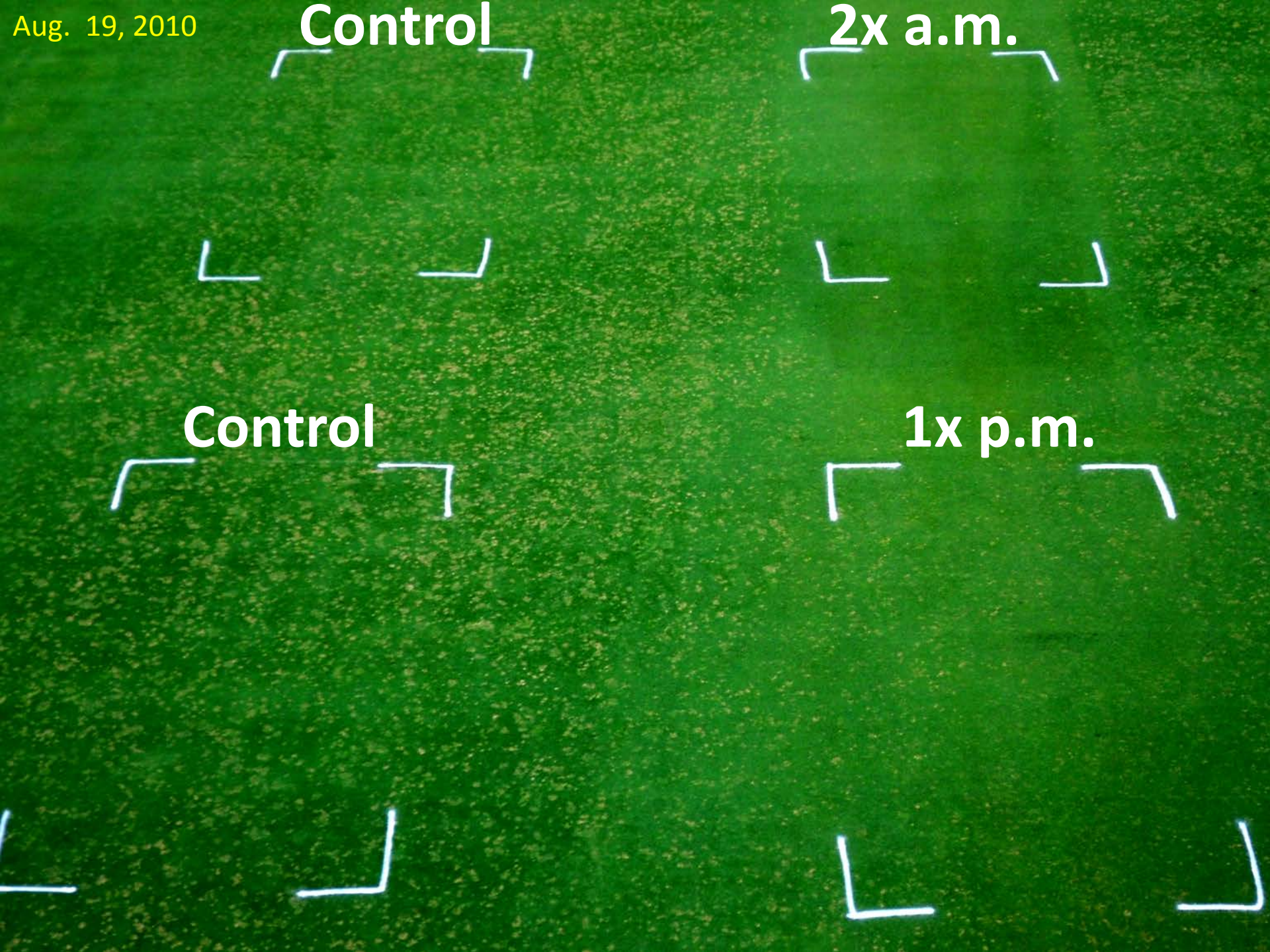


(P < 0.05).


Aug. 19, 2010
Control
1x p.m.


Aug. 19, 2010
1x a.m.
Control


Aug. 19, 2010
Control
2x a.m.


Aug. 19, 2010
Control
2x a.m.
Control
1x p.m.

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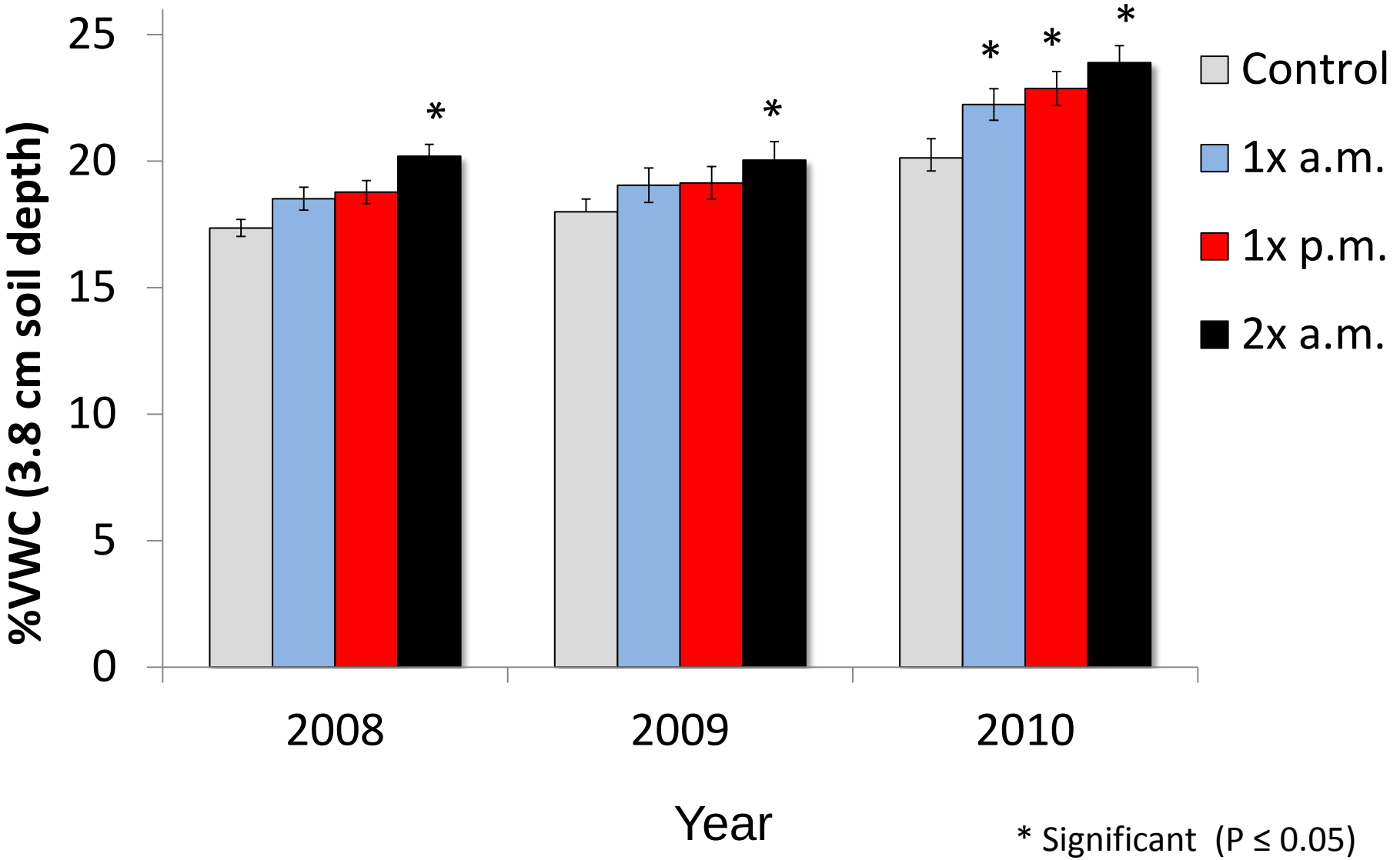
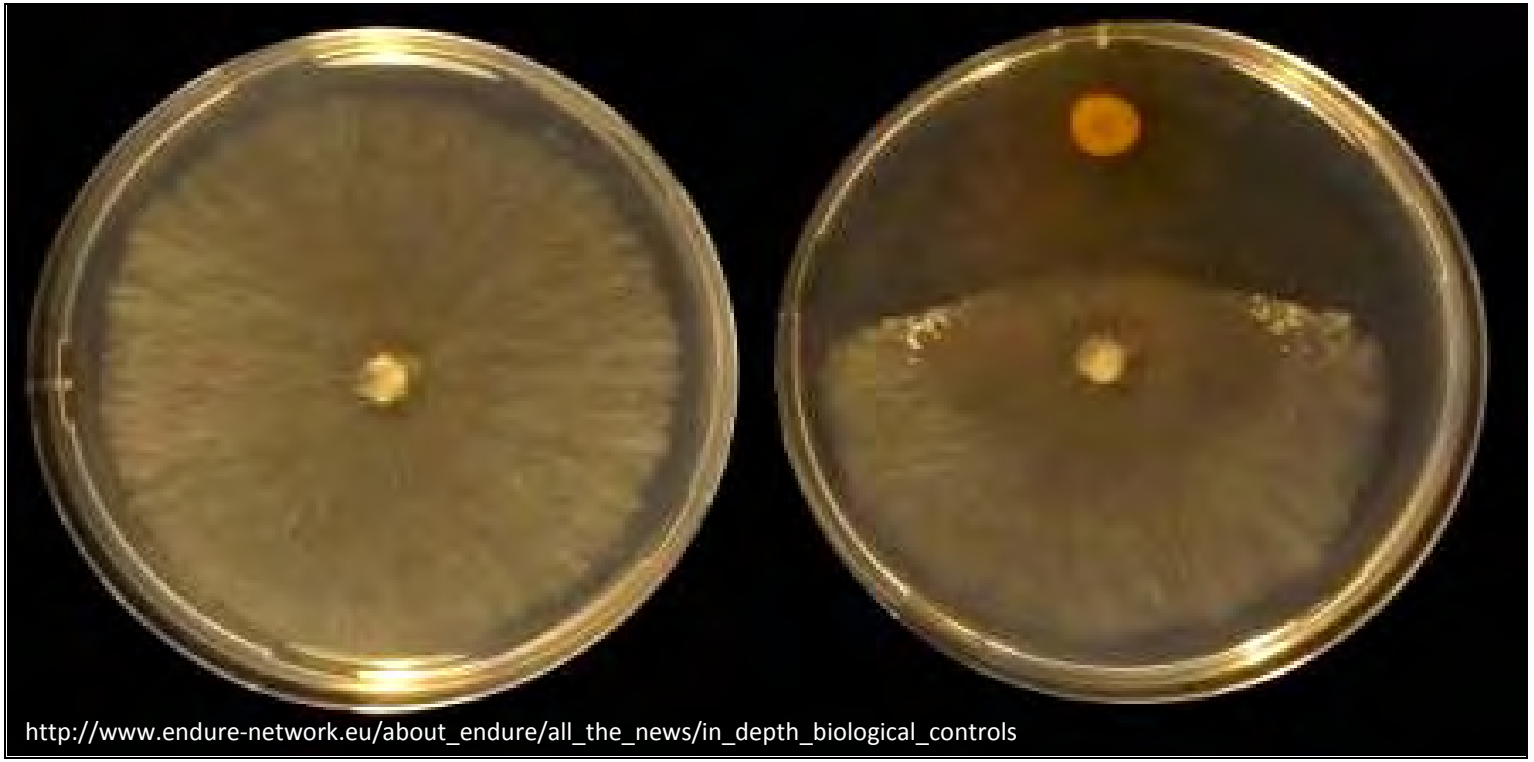
Soil Moisture



Hypothesis II

- Rolling suppresses dollar spot by promoting microbial mediated inhibition (i.e. antagonism, competition etc.)



Bacterial Biological Control

Pseudomas spp.

-*P. aerofaciens*
-*P. aeruginosa*
-*P. fluorescens*
-*P. lambergii*
-*P. putida-fluorescens*
-Other *Pseudomonas spp.*

- -Dollar spot
- -Take all patch
- -*Pythium* spp.
- -Summer patch
- -Brown patch
- -Fusarium spp.
- -Leaf spot

-*Enterobacter cloacae*

- -Dollar spot
- -*Pythium* blight
- -Summer patch

-*Xanthamonas maltophilia*
-*X. campesris*

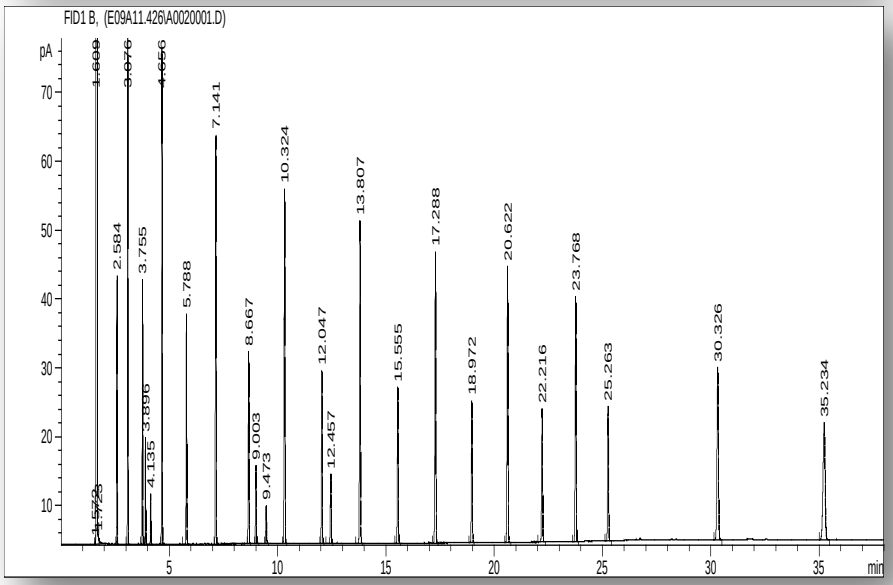
- -Summer patch
- -Leaf blight

-*Serratia marcescens*
-*Serratia spp.*
-*Streptomyces spp.*
-*Bacillus spp.*
-*Various PGPR's*

- -Dollar spot
- -Spring leaf spot
- -Brown patch
- -Pythium
- -Summer patch

Microbial Analysis

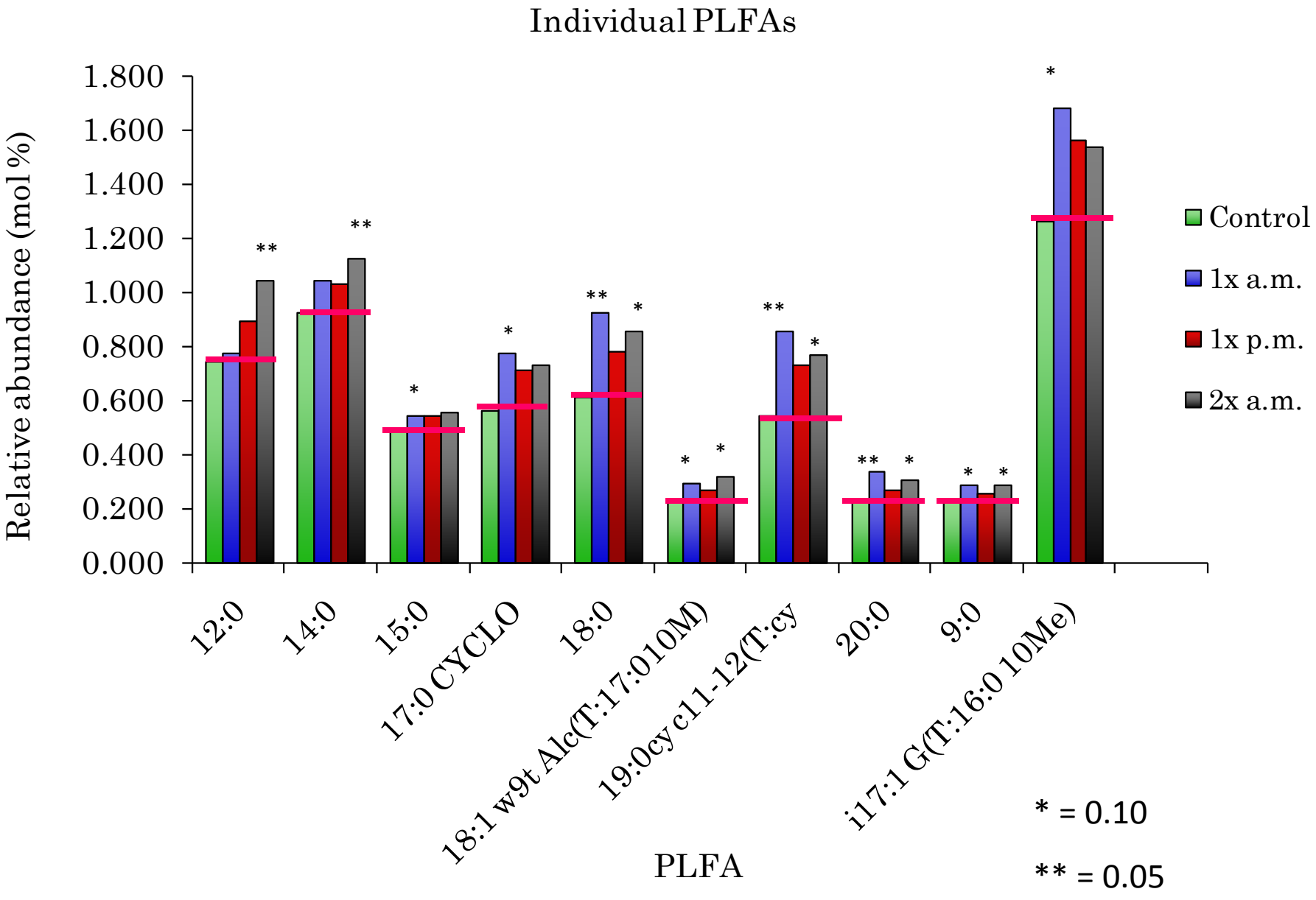
- 20 soil cores taken from each plot
- Homogenized to get a representative root zone sample
- Prepped and analyzed for phospholipid fatty acids (PLFA)
- Measurements recorded and compared



PLFA Analysis

- Extracts fatty acids from soil samples and detects them via gas chromatography
- Different microbial groups can be distinguished by exclusive or shared PLFAs
- By measuring the relative abundance in soil samples, a general “fingerprint” of microbial activity can be obtained

Treatment	Control	Roll 1x a.m.	Roll 1x p.m.	Roll 2x a.m	Lipid biomarker
12:0	0.7446	0.7797	0.8962	1.0465 **	Bacteria
14:0	0.9251	1.0461	1.0315	1.1277 **	Bacteria
14:0 ISO 3OH	0.3279	0.4073	0.3889	0.4011	
14:1 w5c	0.2097	0.2225	0.2189	0.1428	Gram - bacteria
15:0	0.4878	0.5458	0.5477	0.5591 *	Bacteria
15:0 ANTEISO	1.1085	1.4009	1.3757	1.3671	Gram + bacteria
15:0 ISO	2.4031	2.9951	2.8863	2.9857	Gram + bacteria
16:0	15.949	15.599	15.540	15.714	Bacteria and fungi
16:0 ISO	0.5792	0.7681	0.7288	0.7313	Gram + bacteria
16:1 ISO H	0.5080	0.5875	0.6872	0.4279	Gram - bacteria
16:1 w5c	36.410	31.143	32.753	31.896	Arbuscular mycorrhizae (AMF)
16:1 w7c	2.6360	3.0052	2.9218	2.9093	Gram - bacteria
16:1 w9c	0.4481	0.5341	0.5392	0.5150	
17:0	0.1997	0.2736	0.2506	0.1780	Bacteria
17:0 ANTEISO	0.3455	0.4717	0.4321	0.4319	Gram + bacteria
17:0 CYCLO	0.5650	0.77704 *	0.7137	0.7324	Gram - /anaerobes
17:0 ISO	0.3455	0.4717	0.4321	0.4319	Gram + bacteria
17:1 w8c	0.4281	0.5226	0.6033	0.5518	Gram - bacteria
18:0	0.6418	0.9294 *	0.7805	0.8558 **	Bacteria
18:1 w5c	0.4178	1.2252	0.8376	0.4048	
18:1 w9c	7.5882	7.4477	7.5651	8.2416	Sapro or ecto
8:1 w9t Alc(T:17:010M	0.2344	0.29724 *	0.2694	0.3214 **	Actinomycetes
18:3 w6c	0.5733	0.6938	0.6054	0.6865	Sapro or ecto
19:0	0.1188	0.1500	0.1235	0.1483	bacteria
19:0cy c11-12(T:cy	0.5445	0.8611 **	0.7305	0.7731 *	gram - /anaerobes
20:0	0.2255	0.33765 **	0.2714	0.3068 *	bacteria
9:0	0.2318	0.28886 *	0.2576	0.2904 *	bacteria
i17:1 G(T:16:0 10Me)	1.2652	1.6838 *	1.5674	1.5392	Actinomycetes
Sum In Feature 19	3.6361	4.0150	3.1897	3.6111	saprophytic fungi
Sum In Feature 8	4.9095	6.0582 *	5.2525	5.8397	Gram - bacteria

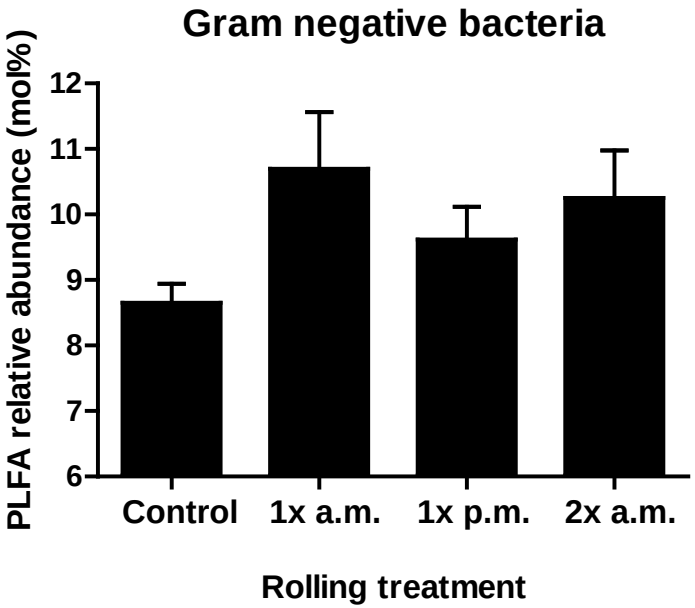

Individual PLFAs
Relative abundance (mol %)
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
Control
1x a.m.
1x p.m.
2x a.m.
12:0
14:0
15:0
17:0 CYCLO
18:0
18:1 w9t Alc(T:17:010M)
19:0cy c11-12(T:cy
20:0
9:0
i17:1 G(T:16:0 10Me)
PLFA
* = 0.10
** = 0.05

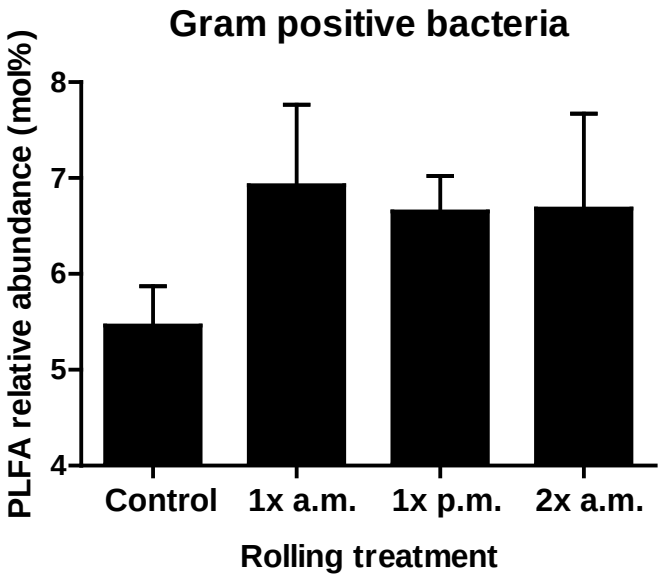
PLFA Grouping

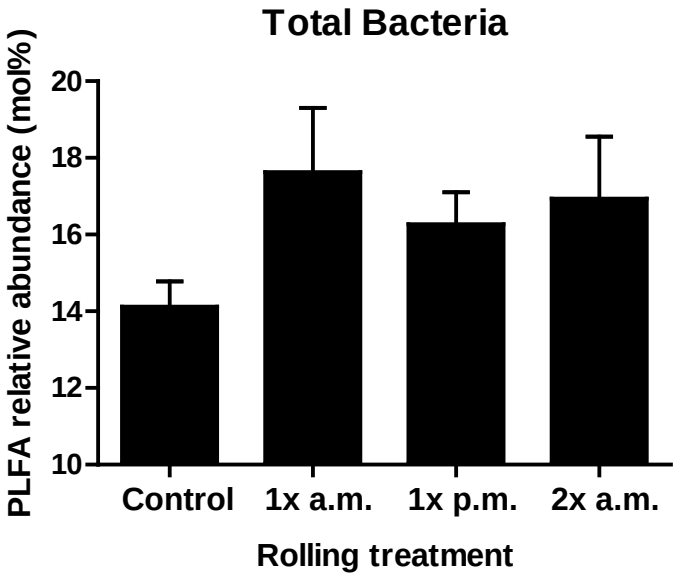
- Care should be taken in connecting individual PLFAs to specific microbial groups; it is perhaps better to look at the trends in **groups** of fatty acids.

Taxonomic group PLFA biomarkers	PLFA group	Specific PLFA markers	Reference
Gram-positive bacteria	**Branched PLFAs**	***i*15:0, *a*15:0, 15:0, *i*16:0, 17:0, *i*17:0, *a*17:0**	**Ratledge and Wilkinson, 1988 and Zogg et al., 1997, Liang et al. 2008.**
Gram-negative bacteria	**Cyclopropyl and mono PLFAs**	**16:1ω7c, cy17:0, cy19:0 and 18:1ω9t**	**Ratledge and Wilkinson, 1988 and Zogg et al., 1997, Liang et al. 2008.**
Fungi	**Polyunsaturated PLFAs**	**18:1ω9c, 18:2ω6c and 18:3ω6c**	**Myers et al., 2001; Vestal and White, 1989, Liang et al. 2008.**
Total Bacteria	**Multiple groups**	***i*15:0, *a*15:0, 15:0, *i*16:0, 17:0, *i*17:0, *a*17:0, 16:1ω7c, cy17:0, cy19:0, 18:1ω9t, 18:1ω7c, cy19:0ω8c**	**Bossio et al., 1998, Ratledge and Wilkinson, 1988 and Zogg et al., 1997, Frostegård and Bååth, 1996, Liang et al. 2008.**

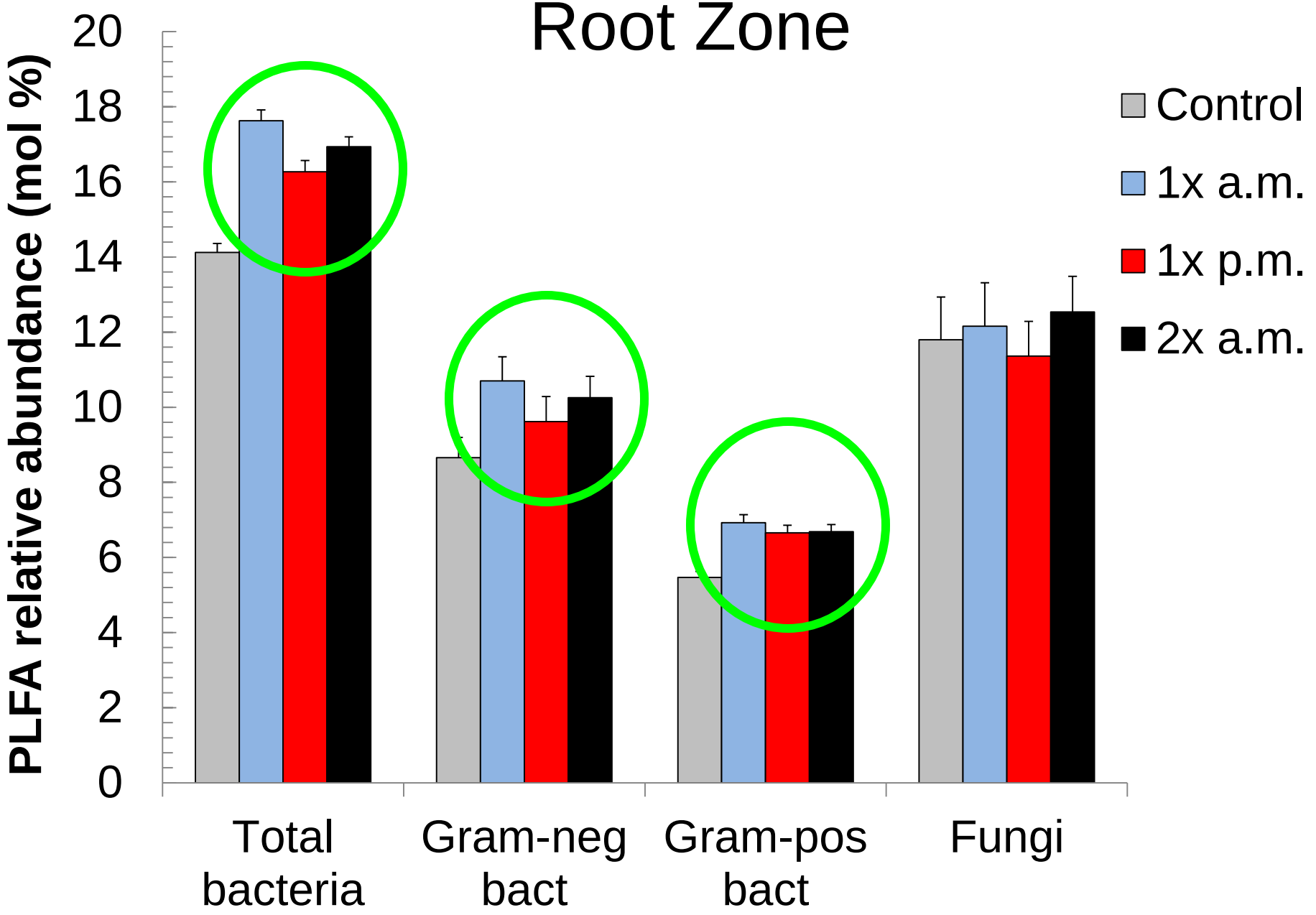
PLFA Groupings



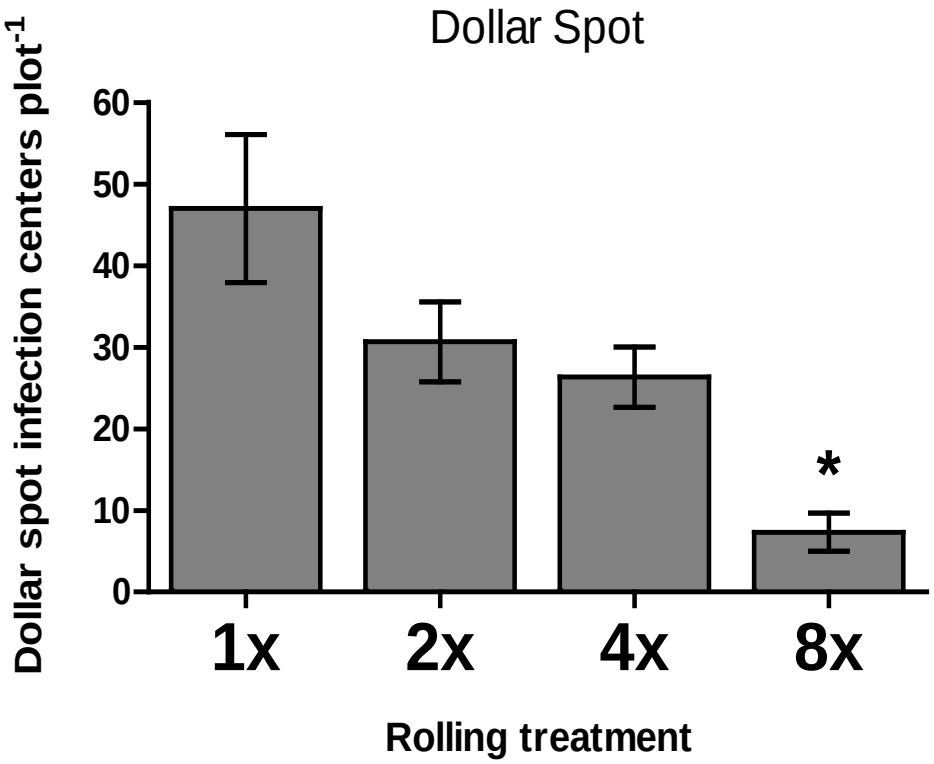


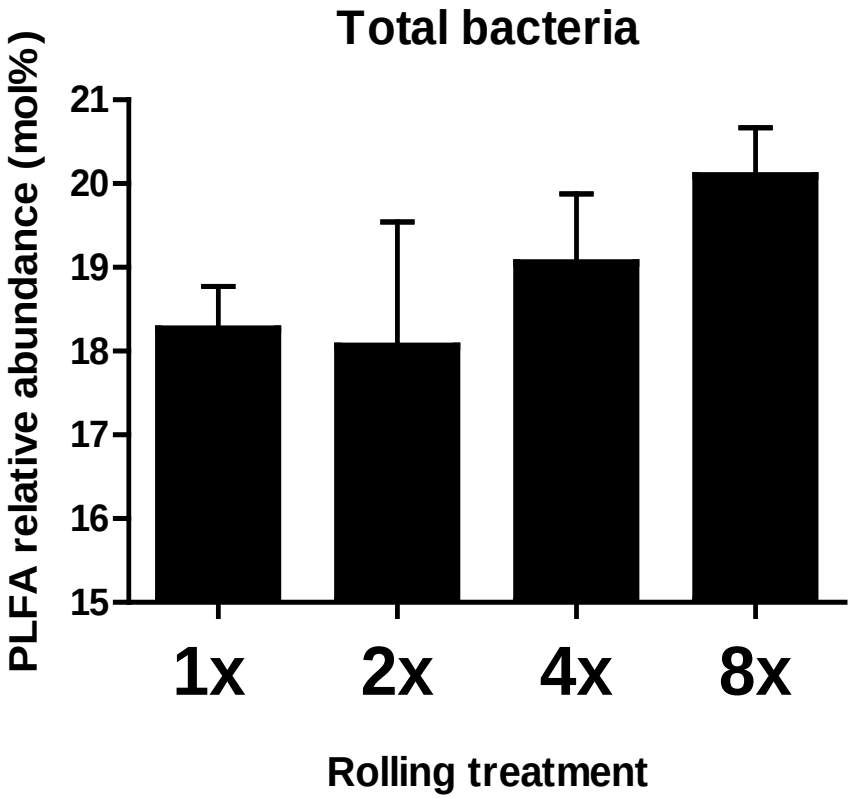


Microbial Abundance in Upper (1.5 in) Root Zone



1x – 8x/day Rolling Study
MSU (2009)





Results and Conclusions

- A.M. and P.M. rolling resulted in significant dollar spot reductions
  - Suggests dew/guttation removal is not the underlying mechanism
- Rolling 2x day^{-1} consistently resulted in the lowest seasonal dollar spot incidence
  - Cumulative effects
- Increases in %VWC in the upper root zone in rolled plots.
  - Potential ecological effects
  - Trends toward higher bacterial proportions
  - Possibly contributing to dollar spot reduction

Special Thanks

Questions?

Photo courtesy of the O.J. Noer Foundation